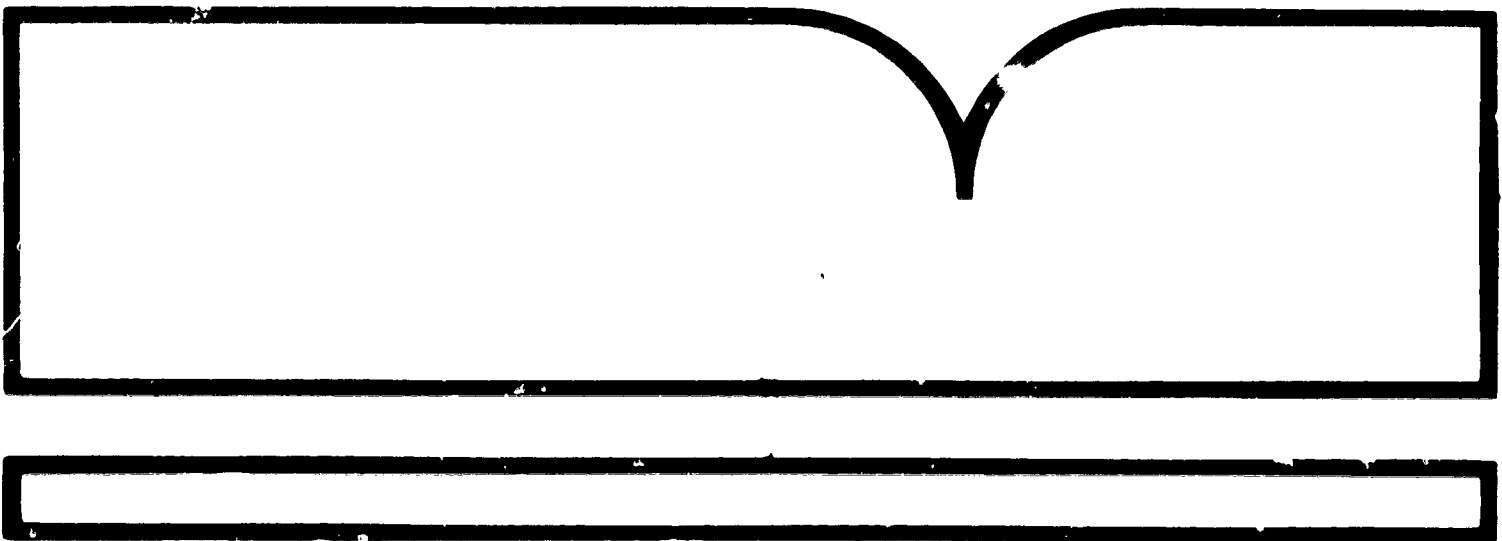


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Quality Improvement Prototype: Johnson Space Center  
National Aeronautics and Space Administration

(U.S.) National Aeronautics and Space Administration, Houston, TX

1990



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## QUALITY IMPROVEMENT PROTOTYPE

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### **Johnson Space Center** **National Aeronautics and Space Administration**



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### Executive Office of the President Quality Improvement Prototype Award

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1990

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*"...with one objective in mind - to keep America first in space, and it's only a matter of time before the world salutes the first men and women on their way outward into the solar system. All of us want them to be Americans."*

- President George Bush

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*"To those who view the awesome challenges we face and turn aside because they fear the future, I say: We can prevail if we work together to rekindle the American spirit...President Kennedy didn't promise us the Moon. He challenged us to get there. It was hard. But we accepted the challenge and rose to greatness."*

- Richard H. Truly,  
Administrator, National Aeronautics and Space  
Administration

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*"...as we look into the future, we see opportunities as challenging and exciting as those of the past. More than in most organizations, our daily tasks in NASA serve as building blocks for the future. We must ensure that we carry our assignments with the highest sense of pride and dedication to quality."*

- Aaron Cohen,  
Director, Lyndon B. Johnson Space Center

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# Foreword

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The President is committed to improving Government products and services. In pursuit of the President's goal, the Office of Management and Budget recognizes Federal organizations that achieve high standards of quality, timeliness, and efficiency. These organizations serve as models to the rest of Government, showing how an unwavering commitment to quality leads to better services and products, more satisfied customers, and reduced costs.

It is my pleasure to announce the designation of the NASA Lyndon B. Johnson Space Center (JSC) as a Quality Improvement Prototype for 1990.

Prior to 1986, JSC was involved primarily with one major program, the Space Shuttle. Today, JSC supports three major efforts: Space Shuttle flight missions, Space Station Freedom, and the development of a lunar base that is integral to the manned mission to Mars. The continuous quality improvement effort initiated in 1986 has enabled the Center to meet these expanded requirements without a significant increase in resources.

JSC accomplishes a significant portion of its mission through contractors. A successful Centerwide improvement project is a redesigned procurement process that has reduced total procurement processing time by 25 percent, eliminated a form used 2000 times annually, and reduced from 57 days in 1987 to 42 days in 1989 the time from the issuance of a purchase request to the placement of the order with a vendor.

Numerous employee teams have contributed to major improvements in both quality and timeliness. For example, a design for reduced thickness criteria for Space Shuttle thermal control system blankets has resulted in estimated savings of more than \$12 million.

We congratulate JSC on setting a fine example of how a Federal organization can improve its products and services by using new approaches to managing for quality.



Frank Hodsoil  
Executive Associate Director  
Office of Management and Budget

# Executive Summary

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The Lyndon B. Johnson Space Center (JSC) is entering a new, dynamic era in the manned exploration of space. In addition to maintaining the Space Shuttle's "Return to Flight" status and supporting the long-duration Space Station Freedom, the Center is embarking on two new interrelated ventures: a lunar base and a manned mission to Mars. To meet the expectations of JSC's ultimate customer -- the United States public -- these complex missions must be carried out safely and effectively within the realities of limited economic resources.

In 1986, the JSC community began to assess its position to meet the challenges of future missions -- both technologically and institutionally. As a result, JSC implemented a continuous improvement approach based upon key principles of Total Quality Management. "Achievement through Team Excellence" was selected as the theme for this effort to reinforce the premise that JSC's most important resource is its people and successful quality improvement requires broad participation at all levels. This premise extends to the Center's contractors as well. Approximately 85 percent of Center funds are expended through the private sector. Recognizing contractors as partners emphasizes teamwork and mutual responsibility for the achievement of common goals.

Improvement activities have focused on three major objectives: establishing a commitment for change throughout the organization; ensuring broad participation by managers and employees in identifying what specific changes need to be made; and putting in place processes to support a continuous quality improvement effort.

Centerwide goals have been established that address not only assigned missions, but also quality concerns such as technology management, institutional excellence, and improved relationships with customers and partners. These goals have been translated into near-term activities directed at improving organizations, systems, and the working environment. The benefits of broad participation by managers and employees have been demonstrated by an increased dedication and commitment to improving quality at all levels. An integrated process is now in place to support continuing improvement based upon strategic planning, culture surveys, and Team Excellence projects.

The continuous improvement effort has enabled the Center to meet expanding mission requirements without a significant increase in resources. The Space Shuttle has been returned safely to flight with nine successful missions. Requirements for assigned Space Station systems and hardware have been defined, a major hardware contract has been put in place, and preliminary designs are currently in review. Conceptual studies for the lunar and Mars initiatives are underway; required technologies have been identified and teams established to pursue development in those areas. This significant increase in capacity reflects improvements being made in work processes and the increasing dedication and commitment of the JSC workforce to excellence in achieving the Center's goals.

Improvements have been implemented in both administrative and technical operations. The time required for processing small purchases was reduced by 25 percent. Supply returns were cut 75 percent. Standardized roof designs were developed to reduce construction and maintenance costs. A new inspection device was developed to enable recovery of development thrusters at a savings of \$1 million each. Implementation of a resources management and scheduling system reduced laboratory labor costs an estimated \$200,000 annually.

The Center is only at the beginning of its journey to Total Quality Management. A strategic approach to change has established direction and commitment. The pace of change and improvement continues to accelerate. However, much remains to be done. Plans for the Center include the establishment of more systematic methods for broadening employee involvement in continuous improvement efforts and the development of better tools and techniques for assessing progress.

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# Section 1: Organization Overview

## I. Mission

The JSC mission is to advance human exploration and utilization of space and ensure the Nation's preeminence in manned spaceflight.

The Center conducts research, development, and operation of manned space systems. It strives to maintain excellence in the fields of project management, systems engineering, life sciences, lunar and planetary geosciences, and crew and mission operations.

Flight crew safety is JSC's primary concern in the development and operation of space systems. JSC employees carry out assigned tasks with technical excellence, initiative, and dedication. The Center provides a working climate that will enhance these efforts. In addition, JSC works effectively with government, industry, and academia--its partners on the U.S. space team.

## II. Organizational Structure

JSC is a field installation of the National Aeronautics and Space Administration (NASA). The Center Director reports to NASA's Associate Administrator for Spaceflight. Together with the George C. Marshall Space Flight Center and the John F. Kennedy Space Center, JSC supports NASA Headquarters in manned spaceflight responsibilities.

The Center has a matrix organizational structure (figure 1). Line organizations have functional authority over staff who support one or more program/project offices (i.e., Space Shuttle and Space Station Freedom). Staff offices support all Center organizations and report directly to the Center Director.

Line organizations have primary responsibility for the Center's continuing improvement effort. The

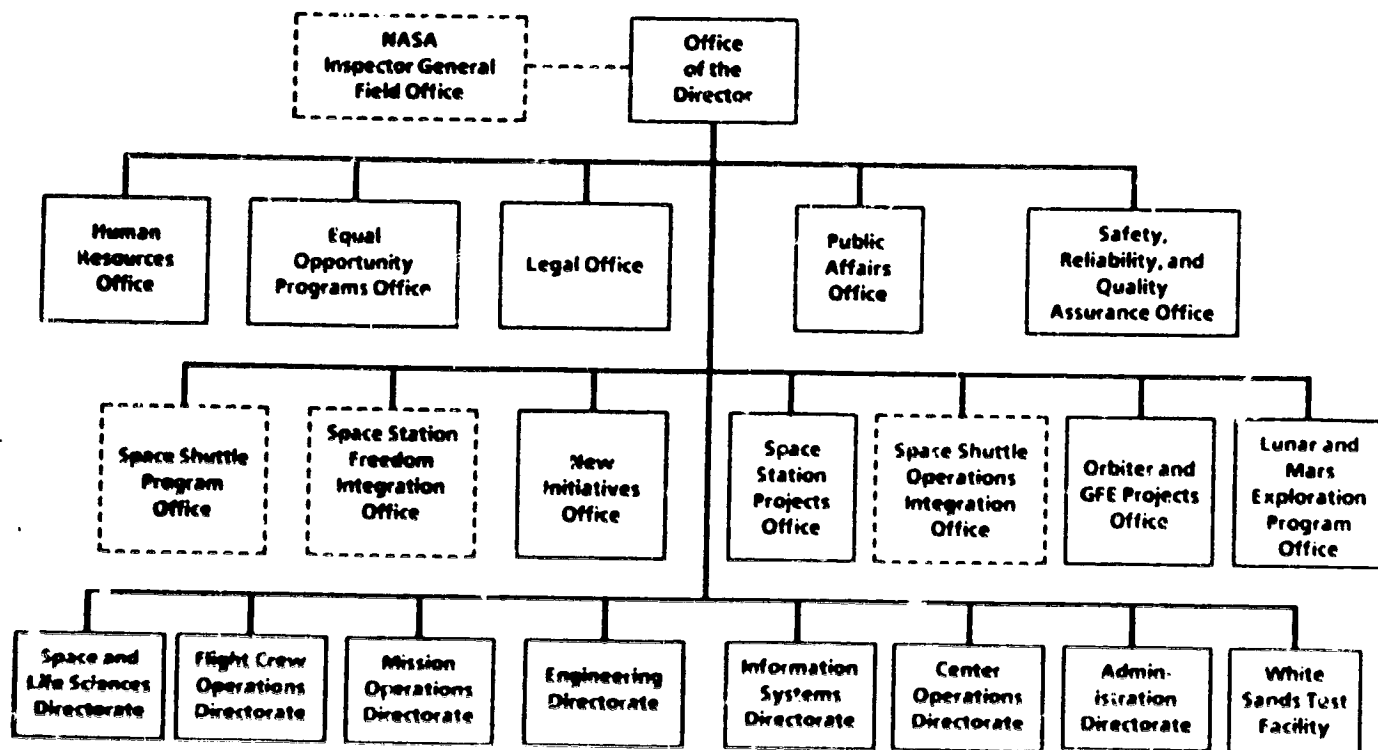


Figure 1.- JSC organization chart.



strategic planning and Team Excellence activities are coordinated by the Management Analysis Office in the Administration Directorate. The culture survey and organizational development activities are coordinated by the Human Resources Office. A small group of consultants supports the activities of these two offices. In addition, the Safety, Reliability, and Quality Assurance Office is responsible for the development and implementation of overall safety, reliability, and quality assurance activities. This office supports quality improvement and the total quality management approach.

### III. Services/Products

In carrying out its mission, JSC provides the following major products and services:

1. Spaceflight operations, such as crew training, astronaut readiness, and flight control technology
2. Engineering and development studies for the advancement of manned and unmanned spacecraft technology and performance capability
3. Scientific, medical, and technological experiments for spacecraft payloads
4. Life sciences research programs to understand the human body's adaptive processes to manned spaceflight
5. Lunar, planetary, and Earth sciences research to understand better the relationship between Earth, its Moon, and other planets

### IV. Staff

JSC is a high-technology organization; 80 percent of its 3,600 civil service employees are engineers, scientists, or in other professional disciplines. An important part of their responsibilities includes management of an annual budget in excess of \$2 billion and a team of contractors that is an integral component of the Nation's manned spaceflight effort. Within the Houston area, there are more than 25 contractors with a workforce of approximately 10,000 that directly support JSC operations. In California, two major spacecraft development contractors with approximately 8,500 workers also support JSC programs.

### V. Customers and Partners

The primary customer of JSC, in the broadest sense, is the U.S. public, whose mandates are expressed by Congress and the President. There are two basic measures of customer satisfaction: first, the degree to which assigned programs are carried out effectively and efficiently; second, the extent to which the U.S. maintains a leadership position in manned spaceflight.

More visible customers of JSC are the various organizations (e.g., other U.S. Government agencies, the scientific community, foreign governments, and the U.S. private sector) that use the Space Shuttle to launch payloads. NASA Headquarters oversees business relations with potential and actual payload customers. The JSC Customer Integration Office supports NASA Headquarters by integrating payloads into Space Shuttle missions. In a similar role, JSC also negotiates and accommodates requirements for the Space Station Freedom Program with the Houston-based offices of Canada, Japan, and the European Space Agency.

In JSC's mission there is an extensive flow of tasks and requirements across organizations both within JSC and among its contractors, other NASA centers, and other independent organizations. Instead of viewing these organizations as customers, JSC prefers using a "partnership" concept in handling quality and productivity issues that arise in task accomplishment. This concept emphasizes teamwork and mutual responsibility for the achievement of common goals.

Approximately 85 percent of Center funds are expended through the private sector. Therefore, it is not surprising that JSC's most important "partnerships" are with its contractors. In fiscal year 1988, JSC expended more than \$1.7 billion with business firms in 45 states and the District of Columbia. Major contractor tasks include spacecraft design, development, testing, and integration; engineering and data processing support; facility and laboratory operations; media services; scientific/medical research; and quality assurance program support. It is critical that every dollar provided by the Government to the contractor community be used effectively. Quality JSC/contractor working relationships support the achievement of this goal.

## Section 2: Program Background

During the 1980s, JSC's quality and productivity efforts evolved from a traditional cost-reduction program into a Total Quality Management approach (figure 2). This evolution occurred concurrently with a growing recognition that fundamental changes were needed to prepare the Center for future manned space programs. Four basic challenges emerged to form the framework for a Centerwide improvement effort:

1. The changing nature of manned spaceflight programs. Programs are becoming more complex, of longer duration, and interdependent; the Space Shuttle is vital for building Space Station Freedom, itself a stepping stone for future exploration.
2. The need to develop new technical capabilities in the rapidly changing world of technology.
3. The need to foster an internal environment that promotes technical excellence, leadership, creativity, and a participative, dedicated workforce.
4. The need to enhance teamwork with customers and partners - a fundamental tenet of success for the U.S. Space Program.

### I. First Steps - Developing Concepts/Techniques (1983 - 1986)

Prior to 1983, JSC's productivity effort focused primarily on traditional cost-reduction and employee-suggestion programs. NASA shifted its productivity approach in 1982-83 when the Administrator established a goal for the Agency to be a national leader in productivity improvement. JSC responded by developing fledgling productivity improvement efforts through a Centerwide productivity committee. A variety of stand-alone productivity initiatives included modified quality circles, or NASA Employee Teams (NETs); revitalization of the JSC suggestion system; and participation in joint NASA/contractor productivity conferences and working groups.

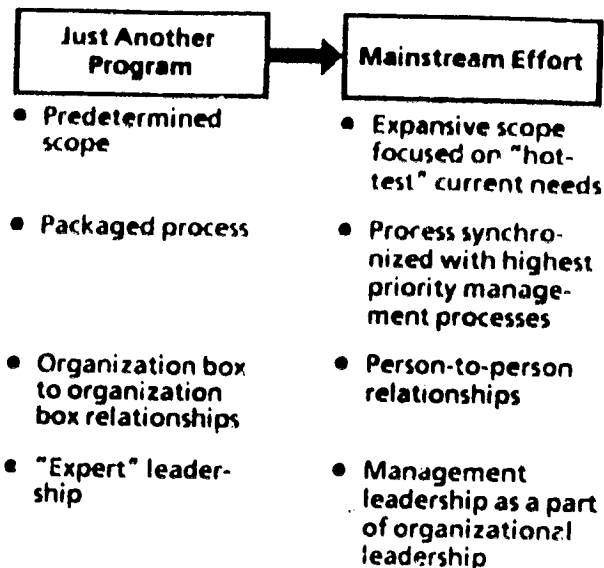


Figure 2.- Moving from productivity to Team Excellence.

Two major efforts focused on developing a better understanding of the full dimensions of productivity in a research and development (R&D) environment. In December 1982, the Center sponsored a national R&D Productivity Conference to increase productivity improvement awareness among both civil service and contractor managers and employees. The following year, JSC served as the lead NASA center for a two-year white collar productivity improvement research project coordinated by the American Quality and Productivity Center. Lessons learned in this project are incorporated in the six-step Team Excellence action process in use today as part of the Center's continuous improvement effort.

During this same time period, the Center also became a member of the Quality and Productivity Management Association (QPMA) and the American Quality and Productivity Center. Center personnel attend conferences, meetings, and training sessions sponsored by these organizations. In addition, Center personnel were instrumental in establishing a Texas Council of the QPMA that provides a forum for area organizations to share their experiences in implementing quality and productivity improvement efforts.

## II. Implementing Initiatives on Three Fronts (1986 - 1988)

Late in 1985, NASA's Administrator called for five year plans from all field installations in response to President Reagan's Productivity Improvement Program. JSC's plan reflected its active involvement in returning the Shuttle to safe flight status, while also focusing attention on the future.

Center management recognized the need to build a technical capability to support the next frontiers in manned spaceflight: a lunar outpost and Mars exploration. To meet this need, a senior management team broadened the focus of JSC's productivity effort, building on lessons learned from the Center's previous projects and the improvement efforts of major U.S. organizations. As a result, the following Total Quality Management initiatives were implemented in the fall of 1986:

1. Strategic planning - provides managers and employees with a compelling, unified vision of the future; fosters a Centerwide understanding of strengths and weaknesses; and identifies the goals and actions required to prepare for the future (figure 3)
2. Employee culture surveys - involve employees and managers in understanding and improving the current work environment

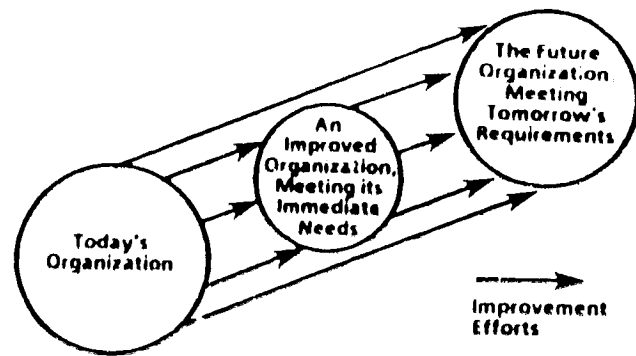


Figure 3.- A strategic approach to quality/productivity improvement.

3. Team Excellence improvement projects - directs improvement activities at all high-priority performance areas; e.g., safety, quality, leadership, participation, teamwork, productivity/efficiency, quality of worklife, innovation, and effectiveness

The numerous activities evolving since 1986 are being increasingly linked with the direction and priorities established by the Center's strategic plan (figure 4).

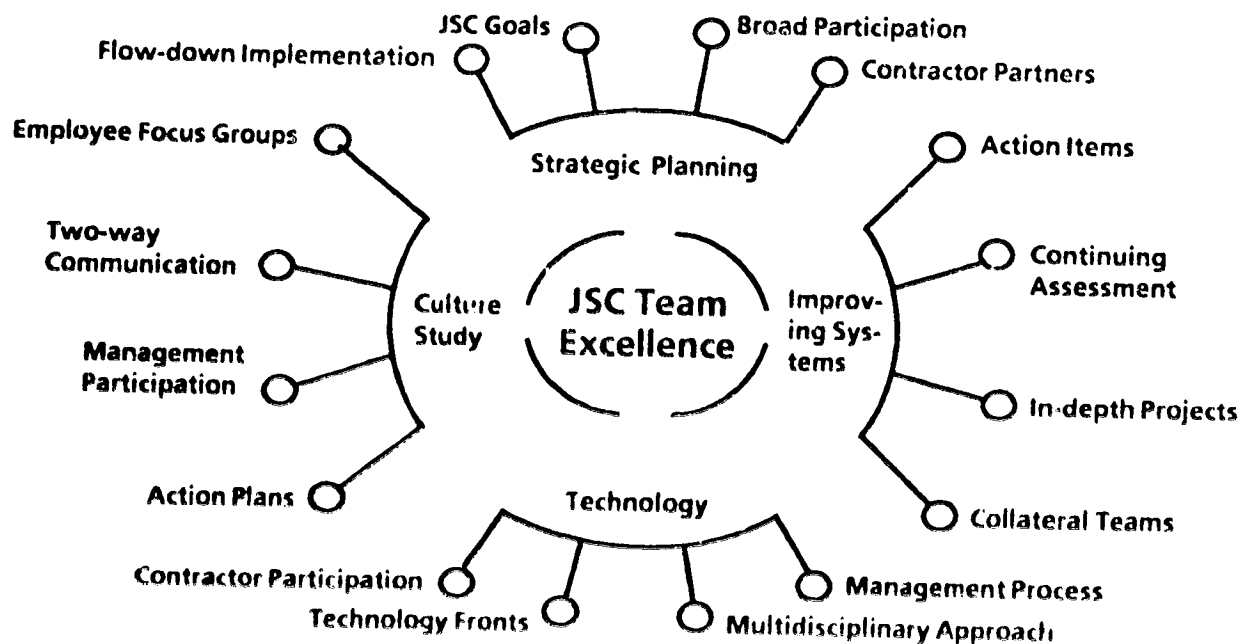


Figure 4.- Elements of JSC Team Excellence.

## Section 3: Improvement Techniques and Methods

Early in the quality improvement effort, JSC management recognized that a change in thinking about improvement was required. The existing focus on making stand-alone improvements was not sufficient for Total Quality Management. The question of whether JSC was doing the right things had to be addressed to provide overall focus and direction.

Strategic planning was the tool used to answer this basic question and to build an understanding throughout the entire organization about the need for change. As managers and employees looked beyond assigned missions and considered what JSC would be doing in the 21st Century, they quickly recognized that new ways of operating were necessary to meet the increasing complexity and interdependence of future programs. Team Excellence improvement projects and the Culture Survey process were identified as the means to implement the fundamental changes identified during strategic planning.

### I. The Strategic Planning Process

JSC's strategic planning emphasizes active involvement by managers and employees in all phases of the process. Management teams and multilevel teams made up of managers and non-supervisory employees are the primary implementing mechanism. This team activity is in addition to normal work assignments.

The process includes three steps: assessment, strategy development, and implementation (figure 5).

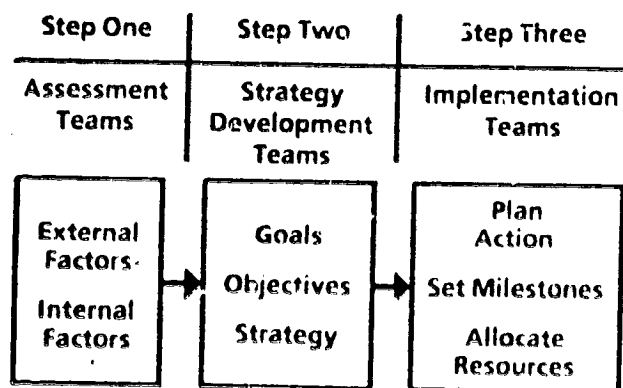


Figure 5. Major steps in strategic planning process.

### 1986 Planning Cycle

It is estimated that approximately one-third of the Center's civil service employees participated in the planning cycle that began in 1986.

Assessment (Step 1): Seven teams of managers and non-supervisory employees were formed from the Center's major functional areas; e.g., engineering, science, operations, institutional support, and information management. Team size ranged from 9 to 22 members. These teams reviewed their respective functional areas and the Center as a whole to identify

1. Suppliers, customers, and competitors
2. Strengths of current operations
3. Opportunities to improve performance

The assessment effort began with a one-day retreat. The teams completed a quick, first-cut assessment of strengths and opportunities that gave participants an immediate sense of accomplishment. A facilitator provided strategic planning tools and techniques to support the group planning process.

During the next two months, the teams conducted in-depth assessments. A consolidated report identifying JSC's strengths and opportunities was presented to the senior staff. Among strengths cited were

1. Informal cooperation at the working level
2. Upward communication
3. Capability to manage, develop, and operate large projects and programs
4. A highly experienced, educated, and dedicated workforce with broad and diverse technical expertise
5. Unique manned spaceflight facilities

Among opportunities cited for improvement were

1. Downward communication
2. Technical capabilities

3. Management attention to personnel development
  4. Delegating authority and responsibility
  5. Upgrading facilities and equipment
- Strategy Development (Step 2):** Members from the assessment teams formed the nucleus of three strategy development groups designated as red, white, and blue teams. Each of these teams included approximately 25 managers and non-supervisory employees representing all major functional areas within the Center. This membership mix ensured that all functions were involved in the development of goals, objectives, and strategies for JSC's current and future space programs.

For each specific program the teams considered

1. How JSC could best participate and contribute
2. The technologies and capabilities required
3. The relationship to known national priorities

Team efforts were initiated with a quick, first-cut assessment of one specific program; e.g., a lunar base. Fourteen programs (e.g., Space Station, lunar base, orbital maneuvering vehicle, Mars sample return) were reviewed over the next several months with 170 technology and capability requirements being identified and assessed.

During this same period, the Center's 20 line organizations reviewed advanced technologies being pursued in their respective organizations. This joint review process provided a basis for comparing current activity with the technology requirements being identified by the teams.

A six-member senior staff steering group, chaired by the Deputy Center Director, provided overall policy and direction. A 17-member working group coordinated the team and functional activities and consolidated the results into a Centerwide technologies and capabilities working document. This report summarized JSC's position with regard to program activities and identified and prioritized technologies critical to the Center's future. Eleven technology areas were recognized as requiring special emphasis to advance the state of the art, e.g., human life support, man/machine systems, space transportation, and information systems.

Five Center goals (figure 6) and 20 subgoals or objectives were developed based on the data collected during assessment and strategy development. A copy of these goals along with other pertinent information was distributed to all Center and contractor employees.

The first two goals focused on technical objectives associated with JSC's current programs: the Space Shuttle and Space Station Freedom. They represented the traditional view that JSC's goals are identical to its assigned missions.

The strategic planning process identified three additional areas as critical to maintaining quality performance. Goal 3 recognized that the foundation for JSC's future is technology and that technical capacity resides in the skills and capabilities of the Center's personnel. Goals 4 and 5 focused on the internal and external environment as critical factors in achieving the first three goals.

**Implementation (Step 3):** Management and employees at all levels participated as major line organizations developed internal implementation plans to meet the Center's goals and objectives. Teams developed guidelines, identified specific actions, set milestones, and allocated resources. In addition, planned activities became a part of individual performance plans as appropriate, thus linking the individual employee directly to the Center's strategic goals.

**Goal 1: Space Shuttle**

Our number 1 priority as the foundation for future missions

**Goal 2: Space Station Freedom**

Extending man's capability in space and providing a bridge to other worlds

**Goal 3: Preparing for the future**

Ensuring that required technologies are developed to meet future mission needs

**Goal 4: Institutional Excellence**

Providing a working environment that promotes excellence and creativity

**Goal 5: Customers and Partners**

Fostering effective relationships among all members of the space team

Figure 6.- The JSC goals.

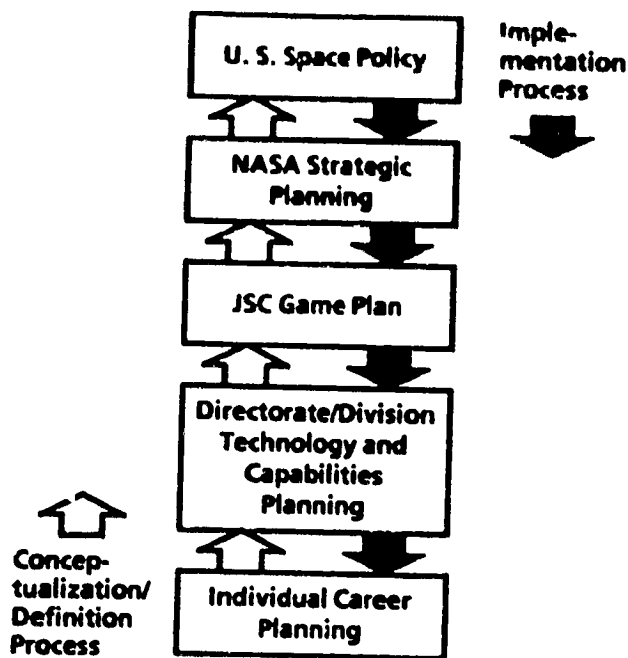


Figure 7.- Multilevel involvement in strategic processes.

Figure 7 illustrates the importance of this multilevel involvement in attaining Center goals.

The working group reviewed the organizational plans and identified 18 Centerwide issues not adequately addressed because they were beyond the scope of individual functional areas. Six "Critical Issues" teams--Space Shuttle, Space Station, Technology, Organization and Management, Equipment and Facilities, and Human Resources--developed specific activities and action plans to address these issues and are overseeing implementation of the action plans.

For example, "special emphasis" teams are developing plans to enhance the Center's capabilities in specific areas of technology. One such team is the Regenerative Life Support Team, which is made up of employees from the four line organizations involved in that technology. This team's activities include

1. Defining life support requirements necessary to support living in space for the extended periods required for lunar outposts and Mars missions

2. Developing a program and implementation plan for required support technologies
3. Identifying relationships among NASA organizations involved with this technology

**Contractor Involvement:** A significant aspect of the implementation phase of JSC's strategic plan is the involvement of the JSC contractor community as partners. In 1988, the Director presented the Center's goals and objectives to contractor executives and sought their comments and support. As a result, three joint JSC/contractor working groups were established by the JSC/Contractor Team Excellence Forum to focus on strategic planning, external relations, and technology. In January 1989, these groups sponsored a joint JSC/contractor workshop to evaluate the Center's strategic planning effort and discuss the direction of future joint activities.

### 1990 Planning Cycle

A reassessment and update of JSC's strategic plan will be initiated in mid-1990. Employees and managers at all levels will be involved in the process, which has four major objectives:

1. To conduct a detailed assessment of progress since 1987, with an emphasis on customer expectations
2. To revise JSC goals and objectives as necessary
3. To develop three- to five-year objectives and milestones as a framework for near-term activities, with an emphasis on quality initiatives
4. To stimulate additional vertical and horizontal information flow and team building throughout the Center

## II. The Culture Survey Process

JSC utilizes NASA's periodic culture survey process to meet three objectives:

1. To increase understanding of the existing work culture

2. To identify and implement improvement as indicated
3. To involve employees in the assessment and improvement process.

A senior management team, led by the Center's Deputy Director and informally known as the "Gang of Five," oversees the survey. Anonymous employee focus groups across the Center assist in interpreting results and making recommendations for work environment improvements. The Center's Human Resources Office coordinates the effort.

The process begins with receipt of the standard NASA survey instrument. Specific JSC questions are added, based upon employee and management input, and the survey is distributed to employees.

Results are reported at both a Centerwide and organizational level. At the Centerwide level, focus groups made up of randomly selected employees from each organization are interviewed regarding the results and recommendations. The Human Resources Office consolidates and presents the survey results and focus group findings to the "Gang of Five." They then compare the results with prior surveys, evaluate actions taken to address prior concerns, and determine what Centerwide actions will be recommended for implementation in the future.

At the organizational level, managers are briefed on the results for their specific organizations and initiate actions through employee task teams. In some organizations an internal Human Resources Council made up of managers and employees provides an ongoing mechanism for addressing work environment concerns.

The first culture survey, conducted in December 1986, asked 174 NASA-wide questions. At JSC it was sent to 25 percent of the civil service population. Areas identified for improvement included communications, role clarity, and career development. A top ten action list for supervisors was developed by the "Gang of Five," approved by the Center Director, and briefings were held for all supervisors. In addition, all employees received feedback on survey results.

Specifically, supervisors were asked to hold regular staff meetings, discuss employee career aspirations and concerns, improving downward communications,

implement job rotation and cross training wherever possible, document relationships between groups, delegate decisions to the lowest practical level, provide rationale for decisions, encourage new ideas, and cultivate an atmosphere of dignity and respect.

The second employee survey, conducted in March 1989, asked 154 questions. Thirty of these questions, developed at JSC, addressed key issues associated with JSC's quality improvement effort. For example, 15 related to customers and partners, 4 to future planning effectiveness, and 4 to workload management.

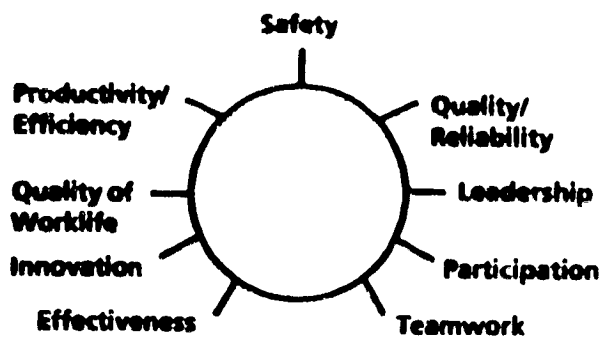
The "Gang of Five" identified four areas for further investigation: decision-making, career development, cooperation/teamwork, and workload. These topics were covered in the 41 focus group meetings conducted in the fall of 1989. As a result of these meetings and input from the Human Resources Office and the "Gang of Five," a series of nine recommendations was presented to the Center Director. These included such items as:

1. Consider increasing the use of rotational assignments (to improve inter-organizational cooperation and teamwork)
2. Review the current management education program to improve its content, set an appropriate standard for continuing education, and make more frequent use of successful JSC managers and supervisors as trainers (to enhance career development opportunities for course participants as well as instructors)
3. Develop a plan to standardize electronic voice and data communications (to increase communications and teamwork)

The Center Director approved each recommendation and requested that specific organizations and individuals be given responsibility for each. Target completion dates are to be set and action initiated as soon as possible.

### III. Team Excellence Projects

Team Excellence projects are the implementation arm of the Center's strategic planning effort. They represent the continuous, day-to-day improvement activities that support the Center's goals and objectives. Organizations are encouraged to concentrate improvement efforts on those activities



**Figure 8.- Team Excellence performance improvement areas.**

that will have the greatest impact on assigned missions and tasks. As a result, the focus of improvement activities varies across the Center (figure 8).

Team Excellence projects include: activities directed at critical issues identified during the Center's strategic planning effort; organizational development efforts supported by the Human Resources Office; the JSC/Contractor Team Excellence Forum; the in-depth assessment and improvement of selected organizations, systems, and/or processes; NASA Employee Teams; and internal actions implemented through normal line channels. Another aspect of the Team Excellence effort has been the development of two new awards to recognize the importance of partnership in quality accomplishment.

### **Technology Management - A Critical Issue**

Technology management is an example of a critical issue being addressed as a result of strategic planning. Prior to 1986, technology was seen only as a tool to be identified and applied in the context of existing, assigned programs. As a result, various areas of the Center pursued the same technologies without any significant interchange. Furthermore, no one was addressing the Center's technology requirements for future missions.

This lack of coordination and management was identified during the Center's initial strategic planning effort as a key weakness for a research and development organization such as JSC. To address this issue, a major improvement project was initiated to develop an effective technology management process. Objectives for the new process are twofold.

First, to develop, define, document, and implement:

1. An overall technology direction for the Center consistent with the goals and objectives of the strategic plan
2. An effective system for the planning and management of technology development
3. An informed, enterprising approach to revolutionary and evolutionary technological advances

Second, to stimulate innovation, creativity, and multidisciplinary approaches in addressing technological challenges

Participants in the improvement process soon learned that there were no readily available examples of existing technology management systems. Technology management is a new concept not only to JSC, but also to many other R&D organizations. As a starting point, the JSC development effort focused on one limited functional area. Employees of the Propulsion and Power Division identified technology fronts such as orbital resupply of cryogenic fluids. The current position and goals for each front were identified and their application to current and future programs was analyzed. Specific performance objectives were defined. A framework for allocating resources across multiple projects was established as well as an approach to ensure adequate resources for development efforts.

A Centerwide project is now in progress. The basis for this effort is the technologies and capabilities assessment developed during the strategic planning process. The Centerwide Technology Issues Team is coordinating this effort, supported by sub-teams focused on specific "special emphasis" areas.

### **Organizational Development**

The Human Resources Office offers organizational development support services to JSC organizations in three areas: developing goals and mission priorities, integrating newly selected managers into their work groups, and identifying issues and problems that inhibit organizational effectiveness. As an example, a one-day transition workshop or a multiday retreat specifically tailored for the organization is held upon request from an organization.



The Human Resources Development Branch conducts anonymous interviews with employees to gather background information. In some cases, the Branch also conducts surveys for the organizations. Following these activities, the information is compiled for presentation at the retreat.

At the retreat, the entire work group, manager and employees, defines the mission of the organization, sets goals, and identifies actions required to accomplish the goals. Emphasis is on participation by the entire work group to increase commitment and teamwork.

This program was initiated in 1988. To date, there have been 42 one-day transition workshops; 14 multiday retreats; 3 organization-specific culture surveys; and 2 strategic planning sessions conducted for various organizations across the Center.

#### The JSC/Contractor Forum

Since more than 85 percent of the Center's funds are expended by contractors, it is not surprising that a unique aspect of JSC's quality effort is the emphasis placed on the partnership with these contractors in carrying out the Center's missions. In 1987, JSC discussed with its contractors what actions each could take to foster improvement initiatives throughout the manned spaceflight community. The result was the establishment of the JSC/Contractor Team Excellence Forum. Its purpose is to jointly explore quality and productivity issues and concerns; to understand contractor needs and expectations; to improve the JSC/Contractor partnership; and to work for overall improvements in spaceflight activities.

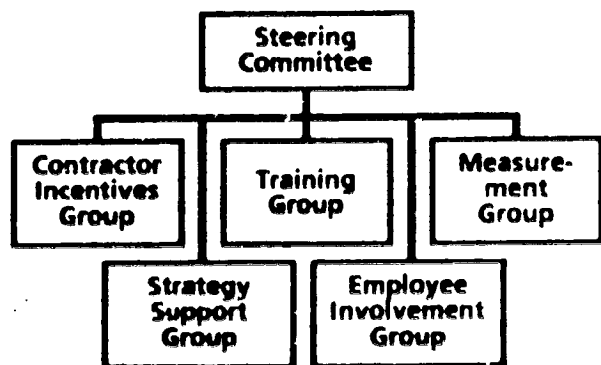


Figure 9.- JSC/Contractor Team Excellence Forum structure.

The Forum, led by the Center's Associate Director and a contractor official, is comprised of managers from JSC and its contractors. The Forum meets periodically during the year; most of the work is accomplished by working groups that address items of mutual interest. There are currently five active groups (figure 9). Those include:

1. The Strategic Planning Working Group, subdivided into three support teams:
  - a. The Strategic Planning Support Team provides an avenue for joint JSC/contractor strategic thinking and assists in evolving the manned spaceflight game plan.
  - b. The Technology Support Team supports the Center's investigation of ways to improve the management processes used to identify, develop, and apply technology to new and existing programs.
  - c. The External Relations Support Team provides a means to furnish the private sector with timely, accurate information on the objectives and benefits of manned spaceflight.
2. The Contractor Incentives Working Group explores innovative contract incentives to enhance quality and productivity in conjunction with JSC procurement personnel.
3. The Training Working Group promotes and facilitates the sharing of training and development programs and sponsors activities to increase awareness and understanding of training technology.
4. The Measurement Working Group explores productivity and quality measurement and provides a means for Forum members to share their experiences with measurement activities.
5. The Employee Involvement Working Group promotes employee involvement among Forum member organizations to increase awareness through education, recognition, and incentives.

Steps	Focus
• Preplanning	• Understanding the process
• Diagnosis	• Where are we?
• Objectives/ Measurement	• Where do we want to go? How will we know when we get there?
• Problem solving/ Action planning	• How can we get there?
• Implementation	• Taking action
• Assessment/Feedback	• Are we on course?

Figure 10.- Six-step action process.

#### In-depth Assessment and Improvement Projects

These projects are led by a working group of supervisors and non-supervisors and typically last from 6 months to 1 year. A six-step systematic problem-solving approach is used that involves employees at all levels (figure 10).

Focusing on customer requirements, participants assess the existing organization, process, or system. Improvements are identified and implemented, and

progress is assessed. The effort is viewed as an initial step toward establishing a continuous improvement process. Advice, analytical tools, and training are provided by a Team Excellence consultant under the Center's Team Excellence support contract. However, the most significant resource devoted to these improvement initiatives is the time committed by managers and employees at all levels.

Examples of these improvement projects at the Center include

1. Projects to improve Centerwide systems. For example, a project to improve the small purchases procurement process involved more than 50 individuals representing procurement, financial management, data processing services, logistics, user organizations, and senior management. Teams representing each of these organizations identified improvement actions to reduce processing time and streamline delivery (figure 11).
2. Projects to improve organizational processes. For example, a project in the Logistics Division involved civil service employees, the support contractor, and representatives from organizations using the Division's services.

Objective	Measure		
	Description	Initial	Target
Reduce average purchase request approval time through delegation	Calendar days from division approval to budget approval	* EA-17 days JA-11 days	8 days 5 days

Action	Responsibility	Status
Establish delegation of directorate-level approval	JA - approval	3/88
Establish budget analysis approval at division level	BA/EA - implementation BA/JA - implementation	Complete 12/87 3/88

Key: \*EA - Engineering Directorate JA - Center Operations Directorate BA - Administration Directorate

Figure 11.- Small purchases process Centerwide initiative, sample action plan - users group.

Surveys and interviews provided the foundation for problem identification and "quick-fix" solutions. Services were identified and priorities established to pinpoint essential activities. Objectives and measurements were established. Opportunities for improvement were identified and action plans developed and implemented.

#### **JSC NASA Employee Teams**

The NASA Employee Teams program, a modified quality circle approach, was established at JSC in 1984 as one of the Center's first employee-participative initiatives. Since that time, hundreds of individuals have participated on these teams, playing an important role in making improvements and in developing teamwork across the Center. In many instances, contractor employees are also team members and help to improve operations which are multi-organizational in scope.

#### **Internal Improvement Actions**

During the first year of the JSC improvement effort, more than 100 internal improvement actions were

identified by JSC organizations. These internal improvement activities are reported annually.

#### **Special Quality/Team Excellence Awards**

Two new awards have been established at JSC to emphasize the partnership concept in achieving quality performance.

In October 1988, the JSC Partnership Award was established by the Safety, Reliability and Quality Assurance Office. This award recognizes the employees or contractors not directly employed by quality assurance for significant contributions to quality at the Center. It is presented quarterly by the Center Director and recognizes both individual and group efforts.

The JSC Team Excellence Award was established in 1988. It recognizes JSC contractors that have demonstrated outstanding dedication and commitment to continuous improvement. It selected two contractor organizations for the 1988 Award. Four contractors received the 1989 Award during National Quality Month.

## Section 4: Status of Quality Effort

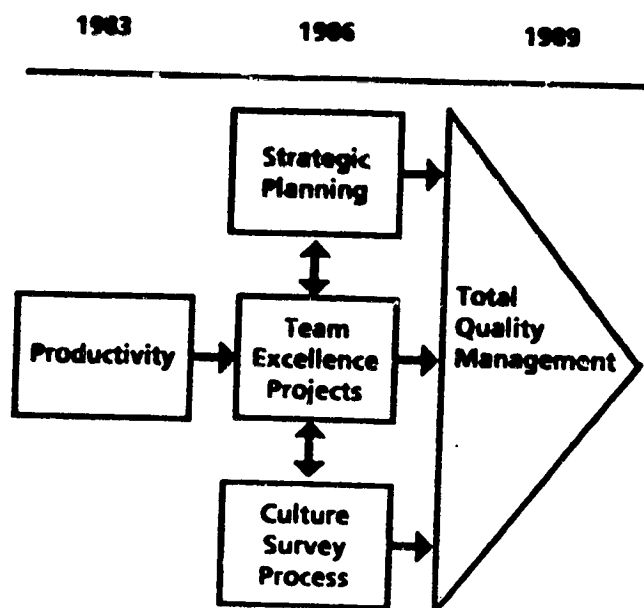


Figure 12.- Evolution of JSC's strategic approach to quality.

Prior to 1986, quality and productivity improvements were viewed at JSC as a collection of relatively unrelated, stand-alone activities. Today, as a result of strategic planning, employee culture surveys, and Team Excellence activities, managers and employees have become familiar with and have used a whole new set of concepts, data, and techniques. A Total Quality Management approach is now firmly linked to the Center's strategic plan, and activities to increase efficiency and effectiveness are an integral part of implementing that plan (figure 12). Overall, the success of Total Quality Management is being measured by the extent to which JSC is meeting the four challenges identified in Section 2 as the framework for the Center's improvement effort.

### I. Changing Nature of Manned Space Flight Programs

One of the most important results of JSC's quality improvement effort is an increased capability not only to carry out existing programs, but also to respond to future U.S. space exploration goals.

Continual streamlining of operations at all levels is enabling the Center to support multiple program efforts without a significant increase in resources.

During the past two years, the Space Shuttle and Space Station Freedom have required unprecedented JSC commitment. The Space Shuttle was returned to flight status, meeting such mission objectives as deployment of two Tracking and Data Relay Satellites, the Magellan planetary probe to Venus, and flights for Department of Defense payloads. Concurrently, the early design stage for Space Station Freedom Program was completed, a major contract was placed for hardware development, and preliminary designs are currently in review.

In addition, JSC personnel actively supported initial planning for President Bush's commitment to charting "...a new and continuing course to the Moon and Mars and beyond." As a result, JSC has a lead role in developing the detailed schedules and resource requirements necessary to support these major new space exploration efforts. Conceptual studies are underway; required technologies have been identified and teams established to pursue development in those areas.

### II. Developing New Technical Capabilities

The New Initiatives Office was established in 1988 to coordinate and oversee technology planning efforts throughout the Center. Under its leadership, teams of technical experts are evaluating existing state-of-the-art against future requirements and identifying methods to stimulate required development. These teams are applying the Center's evolving technology management process (figure 13) to address critical technologies; for example:

1. A Mission Automation Team of 16 employees examines requirements for greater use of automation and artificial intelligence to increase flight safety and significantly reduce ground operational costs associated with spaceflight missions. This team has:
  - a. Identified 13 specific technical areas to be addressed; e.g., program management, man-machine interface

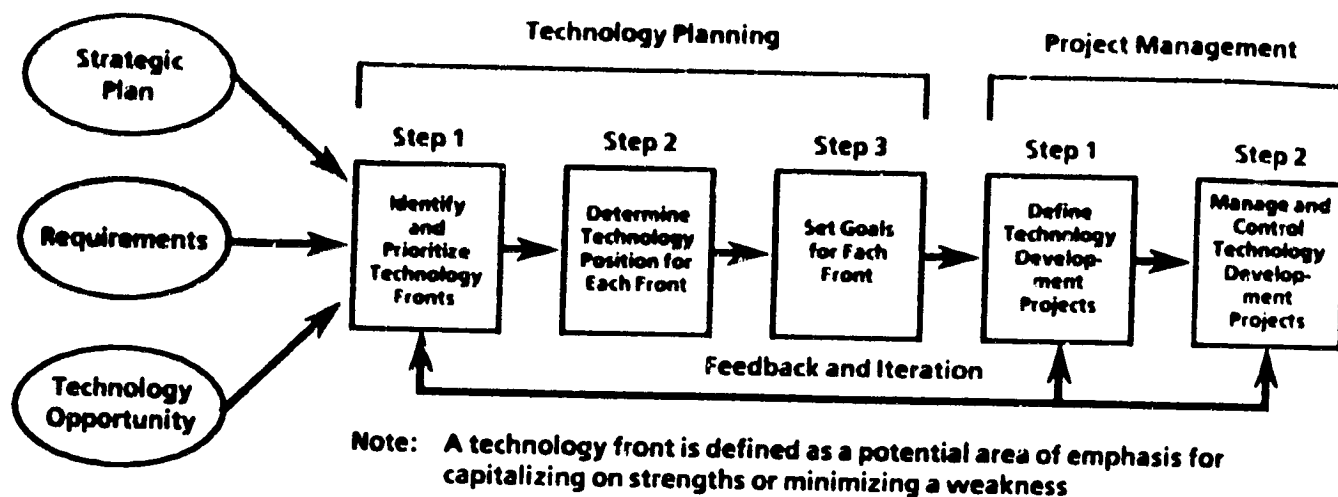


Figure 13.- Technology management process.

- b. Established priorities for proposed projects
  - c. Begun preparing a series of "white papers" containing basic requirements to stimulate new projects in high-priority areas and to ensure that potential applications and customers are included in project plans
2. A Regenerative Life Support Systems Team of 15 employees examines requirements for the extended duration life support systems necessary in lunar outposts and manned Mars missions. The team has:
- a. Identified five specific technical areas to be addressed; e.g., atmospheric renewal, water and waste management, food production
  - b. Initiated the upgrading of an existing test chamber to support research in those areas. This modified chamber will include a physical and chemical atmosphere renewal capability coupled with a plant growth module and associated interfaces
  - c. Completed a draft NASA project plan to provide direction for systems development

### III. Fostering a High-Quality Internal Environment

The extensive and continuing participation by large numbers of employees in strategic planning, the employee culture survey process, and other major quality improvement activities have significantly changed employee attitudes and commitment at the Center. Employees consistently express their appreciation for the opportunity to contribute to future planning and make JSC a better place to work.

An example of the growing enthusiasm and interest among employees is the Threshold Group. The purpose of this voluntary group of young professionals is to contribute to JSC's and NASA's future beyond normal work responsibilities. The group is formally chartered by JSC's senior staff and has more than 200 active members. Goals for Threshold members include doing assigned work to the best of their ability, preparing themselves for the future, fully understanding the work environment, seeking ways to retain corporate knowledge, reducing a sense of isolation among the younger people, promoting NASA's public image, increasing efficiency and effectiveness, and being responsive to management. Projects for the group have ranged from conducting white paper studies for senior management, such as "NASA in the Year 2000" for an Agency-level working group, to building jungle gyms and playroom furniture for a child care center.

## Culture Survey Results

The periodic employee culture survey gives the Center an ongoing evaluation of the organizational environment. Data confirm that employee attitudes concerning the working environment are becoming more positive. With regard to the three action areas identified in 1986, the 1989 responses were more positive for communications, role clarity, and career planning. Figure 14 identifies the five questions that had the largest increases between the 1986 and 1989 surveys. Specifically, these questions indicate the degree to which:

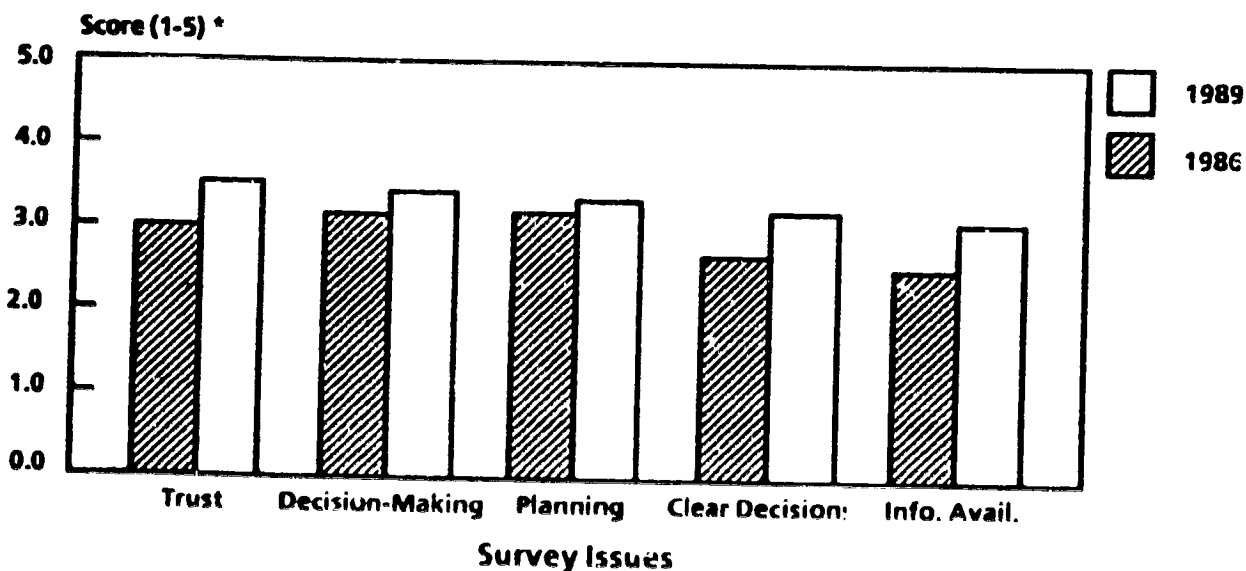
1. Trust is the norm within work units
2. Members of work units are involved in making decisions that directly affect their work
3. There is senior management emphasis on strategic planning
4. There is senior management emphasis on making clear-cut and timely decisions
5. Information is readily available to anyone who needs it

The survey also indicated that JSC has a highly motivated, committed workforce. Employee responses indicated that there was high overall satisfaction with the Center, pride in working for NASA, the perception that co-workers strive to do their best, strong loyalty to NASA and JSC, the view that NASA people value excellence, and the perception that they are involved in decisions that affect their work.

An American Productivity and Quality Center (APQC) survey in which two major JSC organizations participated confirm this assessment. The purpose of the APQC survey was to develop a benchmark of survey data among leading U.S. organizations. Among the 14 organizations participating, JSC's ranking for favorable responses from employees was among the highest, especially in the areas of trust and credibility, teamwork, and organizational functioning.

## Quality Improvements

Numerous quality improvements have been made to increase the effectiveness and efficiency of work systems and processes at the Center.



\* Each 1/10 of a point increase in average score indicates a more positive attitude by approximately 10% of the employees responding to the survey. In this example, the change in the average score on one trust question reflects a more favorable attitude by approximately 3/4 of the Center's employees.

Figure 14: Improved culture responses.

Task Team	Major Project Benefits
User Group	<ul style="list-style-type: none"> <li>- Reduced purchase request (PR) approval time in three major JSC organizations by more than 50 percent</li> <li>- Consolidated certain purchase requests through increased use of "blanket"/"open" agreements</li> <li>- Increased access of procurement data base to user for tracking inquiries</li> </ul>
Logistics	<ul style="list-style-type: none"> <li>- Reduced time PRs spent in logistics by more than 50 percent</li> <li>- Increased proportion of completed purchase agreements, from 60 to 90 percent</li> <li>- Reduced by nearly 50 percent number of days from initial receipt of large, multi-item shipments to final delivery to users</li> </ul>
Financial Management	<ul style="list-style-type: none"> <li>- Reduced by nearly 50 percent number of purchase orders (POs) paid late</li> <li>- Improved system response time from 30 to 5 seconds for financial transactions</li> <li>- Improved routing time by 50 percent on PO receipt and inspection supporting documentation</li> <li>- Reduced calls made to help desk by nearly 50 percent</li> <li>- Reduced change orders from 14 to 10 percent on unpaid invoices</li> </ul>
Procurement	<ul style="list-style-type: none"> <li>- Consolidated PO forms into weekly log format per buyer, reducing JSC Form 497A paperwork volume by more than 90 percent</li> <li>- Reduced the number of individually developed letters by 40 percent through the use of standardized form responses to expedite contracts</li> <li>- Streamlined small dollar item processing by eliminating completion of DOD Form 1784 for purchases less than \$1,000</li> </ul>
Combined Team Impact On Process Time	<ul style="list-style-type: none"> <li>- Reduced average processing time from user request to placement of order by 25 percent</li> </ul>

Figure 15.- Centerwide initiative action plan results.

**Centerwide Systems:** More than 30 improvement actions were identified to streamline the small purchases (\$25,000 or less) process, that handles approximately 4,000 purchase requests annually. The number of change orders was reduced by approximately 50 percent, system response time for financial transactions was improved from 30 to 5 seconds, a form used 2,000 times annually was eliminated, and a reduction of 25 percent in required processing time was realized (figure 15).

**Systems Analysis/Organizational Development:** More than 500 civil service and contractor employees participated in nine in-depth review and improvement projects initiated by seven major organizational components. One example is a project in the Orbiter and Government Furnished Equipment

(GFE) Projects Office directed at improving organizational effectiveness and encouraging teamwork and participation among all managers and employees. Surveys and interviews were conducted of Orbiter office personnel. In addition, contractor personnel and other JSC and NASA personnel from Los Angeles, California, to the Kennedy Space Center in Florida, were interviewed to get their perspective as partners of the Orbiter organization. Action plans for improvements were developed and implementation of these plans is in progress.

To date, improvements have been made in communication and coordination, project management, and meeting management. For example, the use of electronic mail has increased the timeliness of communication between JSC and the contractor in

California, systems automation has provided greater planning and scheduling visibility, and publication of agendas in advance has improved the quality of meeting presentations and discussions. In addition, the project has developed a greater can-do attitude and approach in the organization.

Another example is a Logistics Division project involving civil service employees, the support contractor, and representatives from organizations using the Division's services. Surveys and interviews focused on overall service improvement and teamwork. A streamlined purchase request review process resulted in a 57 percent reduction in processing time. A user-friendly supply system catalog for secretaries reduced time required to locate items by an estimated 50 percent with a 75 percent reduction in rejects. Improved procedures provided more timely delivery of supplies; for example, time for delivery of large, multi-item shipments was reduced from nine to five days. In addition, intangible benefits included improved communications within the Division (including contractors and with customers), an increase in innovative thinking and creativity, and improved teamwork and morale as employees saw their ideas implemented in their work areas.

**Internal Action Items:** More than 50 internal action items were reported by JSC organizations during for Fiscal Year 1988 covering improvements in functional areas across the Center such as:

1. Reduced design thickness criteria for Space Shuttle Thermal Control System blankets for an estimated cost avoidance of more than \$12 million
2. Implementation of a laboratory resources management and scheduling system that is saving an estimated \$200,000 annually in manpower cost
3. Development of a injector flow inspection device to enable recovery of contaminated development thrusters at an estimated savings of \$1 million each
4. Revision to the build and flow plan for delivery of the orbital maneuvering systems pods for OV-105 that decreased schedule by 5 months and lowered cost of the vehicle by more than \$1 million

5. Development of standard roof designs for use on new facilities or reroofing projects for an estimated savings of up to \$1 million over a 10-year period

**NASA Employee Teams (NETs):** NETs Teams, active primarily between 1984 and 1986, provided a number of significant benefits including the following:

1. Improvement in facilities design procedures reduced turnaround time from design inception in final drawing and specification and yielded more than \$24,000 in annual savings.
2. A redesigned purchase order form and improved procedures resulted in an annual cost savings of approximately \$80,000.
3. Improved procedures for correspondence associated with astronaut appearances reduced the time required for responding to requests with an associated 15-percent reduction in phone calls concerning request status.
4. A formal metrology training program for personnel in the Measurement Standards and Calibration Laboratory increased the competency of personnel and reduced research time and calibration errors.

#### **IV. Enhancing Teamwork With Customers and Partners**

Many JSC organizations have been identifying the internal customers they serve and their partnerships with other organizations in accomplishing assigned tasks. Examples of the numerous actions taken to provide better service include the following:

1. The Logistics Division has provided easier customer access through publication of a User Guide, minimized the number of supply requests rejected due to incorrect documentation, improved customer education and awareness by instituting a policy of one-on-one training sessions on request for property custodians, and improved shuttle bus operation to better serve employees with a tenfold increase in ridership.



2. The Travel Section has issued a brochure that provides a concise summary of travel regulations to assist travelers. In addition, meetings have been conducted across the Center to improve communications between Travel and its customers.
3. The Management Analysis Office has published a brochure describing the services of its office and identified points of contact.
4. The Public Affairs Office has implemented a recorded information service for JSC and contractor employees to provide daily updates on NASA programs and other space-related activities as well as other Government and JSC news.
5. The Administration Directorate uses the Center's electronic network to distribute information and provide a listing of current Center directives.
6. The Data Systems Processing Division maintains a help desk to provide prompt assistance to Center employees in using various computer systems and software.
7. The Public Affairs Office has implemented an electronic news service "bulletin board" for access by reporters and aerospace public affairs professionals.

quality/productivity measurement activities in their respective organizations

4. Sponsorship of a joint JSC/Contractor strategic planning workshop and input to the Center's planning activities
5. Establishment of a quality and productivity section in the JSC Technical Library
6. Continuing discussions between contractor and JSC procurement staff on potential contract improvements to stimulate increased quality and productivity

## V. Future Directions

In JSC's complex R&D environment, an integrated approach using a variety of change techniques is required. Many of these techniques are in place. It is now time to increase the pace of JSC improvement activities and move into a third phase or level of commitment to Total Quality Management. Current planning is being directed toward

1. Systematically broadening manager and employee involvement by developing and implementing Total Quality Management planning workshops adapted to an R&D environment
2. Initiating a systematic evaluation of JSC partnerships to increase teamwork capabilities
3. Taking follow-up actions at all organizational levels within JSC on the results of the most recent employee survey
4. Continuing to focus on improving critical activities and processes identified by strategic planning

**JSC/Contractor Team Excellence Forum:** The JSC/Contractor Team Excellence Forum has been meeting regularly since it was established in 1987, with approximately 35 participating contractor organizations. More than 100 JSC and contractor representatives are participating in working group activities such as:

1. Special presentations on quality management topics such as measurement, training, and strategic planning at Forum meetings
2. Publication of a training directory to identify training resources that can be shared by member organizations
3. Publication of a directory of contacts in member organizations available to discuss

The Center is only at the beginning of its journey to Total Quality Management. A strategic approach has provided direction for future efforts and established commitment to continuous improvement as the key to meeting the challenges of the next decade and beyond.

## Section 5: Key Personnel

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### The JSC Civil Service and Contractor Team

In addition to the following contributors, every employee who strives for excellence is a key person in JSC's Total Quality Management effort.

#### NASA Lyndon B. Johnson Space Center

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